Manufacturing an AC Photovoltaic Module

Highlights

- The SunSine™300 AC PV module is listed by UL and certified by the FCC
- SunSine™300 is being commercially produced
- Proprietary inverter makes SunSine™300 inherently safe for utility workers
- SunSine™300 voted "Best of What's New" by Popular Science

This Ascension Technology project is part of the 1995 solicitation of PVMaT—a cost-shared partnership between the U.S. Department of Energy and the U.S. PV industry to improve the worldwide competitiveness of U.S. commercial PV manufacturing.

PVMaT Fact Sheet

Photovoltaic Manufacturing Technology

Ascension Technology, Inc.

Goal

Ascension's goal under the 1995 PVMaT solicitation was to develop an integrated, grid-tied, AC photovoltaic (PV) module—the SunSine™300—for residential and commercial markets.

Background

PV systems can be deployed on dual-use spaces like residential rooftops. Such systems typically supply the building with electricity and send excess generated electricity to the local utility grid. PV modules, however, produce DC electricity, whereas residences and utility grids require AC electricity. So, the DC output of the modules must be routed to a central power conditioner, which converts the current to the proper AC signal.

This process has drawbacks: 1) the PV system must be configured to match the requirements of the power conditioner; 2) wiring for high voltage or high DC current is required; 3) DC balance-of-systems hardware is more expensive than its AC counterpart; 4) these systems need specialized engineering and design support; and 5) hardware is not currently available to configure systems of this type in sizes smaller than about 2 kW.

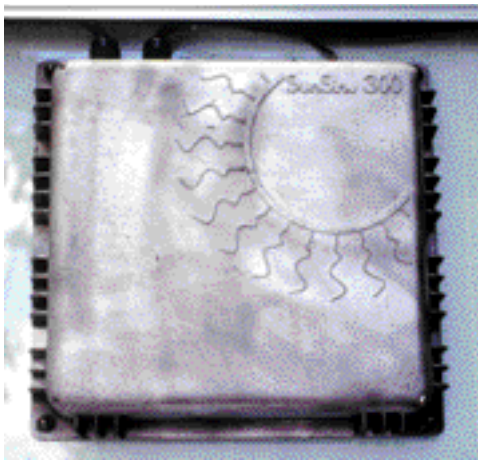
Technical Approach

To circumvent these drawbacks, Ascension Technology designed an AC module—the SunSine™300—that integrates a DC PV module and a DC-to-AC inverter.

The module is a modified version of ASE Americas'ASE-300-DG/50 PV module. It uses 216 crystalline-silicon cells and generates a maximum DC output of 300 watts under an insolation of 1000 W/m^2.

The inverter, Ascension Technology's proprietary design, converts the DC power from the module to AC power that is fed into the electrical grid.The inverter uses a "fail safe" design that shuts the unit down if any component fails, uses an internal transformer for isolation from the grid, produces no output power until correctly connected to the grid, and disconnects from the grid during a power outage of the grid.

The inverter, encased in aluminum, is integrated onto the back-panel laminate of the module. The result is a 55.3 kg (122 lb) module that is1.9 m x 1.3 m (about 6 ft x 4 ft) and delivers a maximum AC output of 300 watts and a rated AC output of 251 watts at standard test conditions.



Ascension Technology, Inc./PIX05940

Ascension's SunSine™300 incorporates a 300-watt inverter (shown), neatly packaged onto the back of the module.

Results

To establish commercial viability, the SunSine™300 had to pass stringent requirements for reliability, safety, and performance. So the modules were subjected to Highly Accelerated Life Test (HALT) and Highly Accelerated Stress Test (HAST) conditions, Underwriters Laboratories (UL) tests, and tests for meeting regulations of the FCC.

HALT/HAST Tests

For HALT and HAST, the modules were subjected to extreme conditions, such as vibrations and rapid thermal transitions, which force failure modes to show up quickly. The tests identified deficiencies in design and assembly procedures. Based on the findings, Ascension modified the inverter to be more reliable to meet UL requirements.

UL Tests

To win a UL listing, the SunSine™300 was subjected to a preliminary study that determined 16 areas of concern and 20 tests the product would undergo during factory testing.

After the product was redesigned, it was subjected to factory tests on three occasions. After the tests, UL gave the module informal approval. In October 1997, UL formally stated that SunSine™300 met the requirements of UL 1741 (Standard for Power Conditioning Units for Use in Residential PV Power Systems—see table). This listing indicates that the module is a safe and reliable product for use by consumers.

UL 1741 Test
60°C Ambient Temperature Test
Verification of Nameplate Ratings
Anti-Islanding Protection
Utility Fluctuations
Transformer Burnout
AC Short-Circuit
Grounding Impedence
Water Spray (Rain Test)
Temperature Cycling, 40 Days
Capacitor Fault Test
Dielectric Voltage Withstand
Harmonic Distortion
DC Injection
Loss of Control Circuit
Output Overload
Components Faults, Shorts/Opens
Strain Relief
Materials Accelerated Aging
Humidity Cycling, 10 Days

FCC Class B Tests

The SunSine™300 also passed the FCC Class B tests. These are guidelines for preventing electromagnetic fields from interfering with household devices such as televisions, radios, and cordless phones.

The SunSine™300 met the guidelines because it uses both filtering and shielding to prevent electromagnetic fields from escaping the enclosure that houses the DC-to-AC converter.

Production

Ascension teamed with Omnion Power Engineering Corporation and ASE Americas to manufacture the SunSine™300. Omnion manufactures the inverters and ASE Americas supplies the DC modules. Ascension Technology integrates the inverters and modules at its facilities in Lincoln Center, Massachusetts, markets the product, and ships it to customers.

Pilot production spanned September 1997 to the spring of 1998, with 109 units being built and shipped. Most were purchased by 16 electric utilities for testing and evaluation.

Today, the SunSine™300 is being made commercially. In its first year of production, more than 300 units have been shipped—with no module failures related to inverter production. Currently, production is limited by the number of inverters that can be produced—2500 units per year. This represents 627.5 kW of rated AC capacity per year.

Inventions/Patents

Ascension has developed a proprietary method—the Zebra™—for islanding protection."Islanding" occurs when utility power is shut off, but independent generating systems remain actively tied to the grid, which thereby creates islands that send electricity onto the grid. Islands pose obvious hazards for utility repair crews.

Zebra™ achieves islanding protection by using a circuit that dynamically controls the output current waveform and watches the voltage waveform for feedback.When the utility is disconnected and an island is formed, the feedback mechanism alters. The unit senses the condition and quickly and automatically shuts down, thus isolating the unit from the grid.

Company Profile

Since this PVMaT project was completed, Ascension has been acquired by IDACORP.

Before the acquisition, the company completed many projects for electric utilities, PV companies, and government agencies. It has installed more than 1.5 MW of PV systems in the United States and other countries.

The company's capabilities—which center around engineering analysis, PV systems, and instrumentation—are based on the staff's in-depth understanding of engineering issues associated with PV system design and performance, distributed electric power generation, interconnection of distributed generation with electric utilities, and engineering economics.

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